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DIAMOND PYTHON - SOUTH COAST NSW

photo Ross Bennett

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OBSERVATIONS OF *CTENOTUS ANGUSTICEPS* *(Scincidae)* on Airlie Island

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Ctenotus angusticeps (Fig 1) is a small, slender, narrow-headed, faintly patterned member of the C. pantherinus group Storr (1975). It was described by Storr (1988) from a series collected during a biological survey on Airlie Island (21°20'S, 115°10'E), located approximately 35km N.N.E. of Onslow, on the north-west coast of Western Australia (Fig.2).

We visited Airlie Island on 12-13 March 1990 with the aim of recording data in the field and to photograph a specimen. Our observations provide important information on the ecology of this restricted and endangered species.

The island is small and low comprising a total area of ca 0.28km^2. A considerable amount of the island's area is used by Western Mining Corporation Ltd including cleared land for roads, oil storage and processing facilities. The dominant vegetation consists of Acacia coriacea shrubland community with coastal Spinifex sp. in the littoral zone. The western end of the island has extensive tussock grass coverage of unknown species where A. coriacea is sparse. At this time of year the central part of the island is green due to a form of ground cover. The only rock formation consists of eroded limestone on the beach. Substrate is coarse, dull orange-brown with shell material.

The weather over the two days was fine/clear and very hot, minimum and maximum temperature range was approximately 25-40°C in a 24 hour period. Our searching during the heat of the day yielded only a small number of C. angusticeps, as would be expected. Those seen were foraging under the Acacia shrubs which would provide the animals with shelter from heat. This hot weather activity reveals C. angusticeps as being fairly heat tolerant and able to forage and remain active to an extent throughout the day. The low, open nature of the vegetation exposes the island's surface, therefore the effects of this constant exposure may be a catalyst for natural selection in a geographically isolated population from the ancestor.

We assumed the peak of activity would be when the heat is less severe ie., early morning and late afternoon. Searching time was concentrated in these periods and as a result we observed ca. 35 adult skinks, most of which were active during the morning between 7.00 - 9.00. They were seen in all vegetation types during that time, although they exhibited a marked preference for the tussock grass at the western end. Our observations indicated that C. angusticeps was more prevelant in this tussock grass area and utilised it for shelter. The dead tussocks collapse on to the ground and create a dense mat. They were full of invertebrates when examined, so additionally providing a source of food. From our observations it seems that this species is common on the island, however its future survival is under threat. To our knowledge the sole population is confined to this small island reserve. The activities of Western Mining Corporation Ltd put added pressure by disturbing its already restricted range. If C. angusticeps is to be preserved these activities will need to be carefully monitored.

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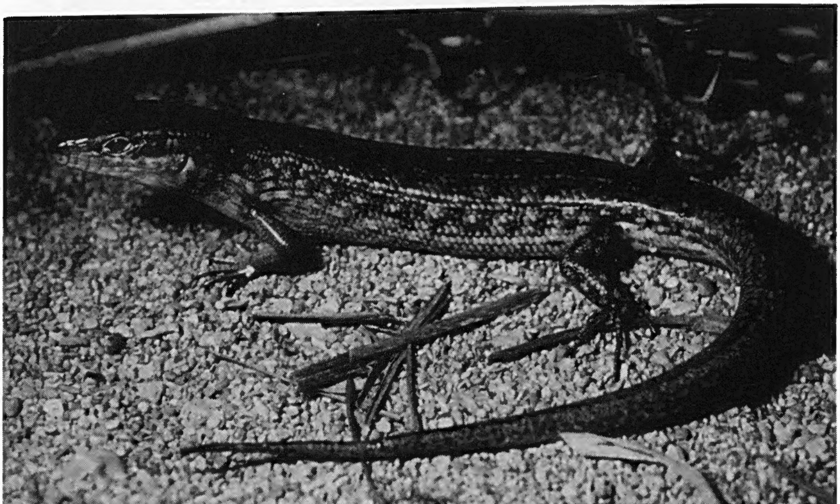

Figure 1. Adult *Ctenotus angusticeps*

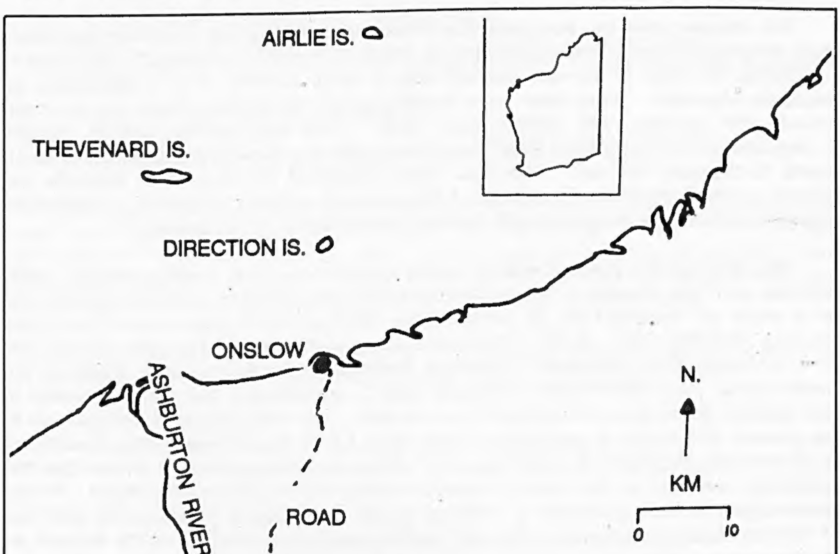

Figure 2. Map showing location of Airlie Island

REPTILE DENSITIES IN CHENOPOD SHRUBLAND AT OLYMPIC DAM, SOUTH AUSTRALIA

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INTRODUCTION

Chenopod shrublands occupy 24% of South Australia (Graetz and Wilson 1984), and form the major vegetation association of the semi-arid zone of this state. Chenopods support a diverse reptile community and 25 lizard species have been recorded from this association at Roxby Downs, South Australia (O.D.O 1990). This figure exceeds the maximum lizard diversity recorded for comparable environments on other continents, such as the North American and Kalahari deserts which support 11 and 18 species respectively (Pianka 1986). The lizard communities of chenopod shrublands, however, are considerably more depauperate than spinifex grasslands, where over 40 species have been recorded in both the Great Victoria Desert, Western Australia (Pianka 1986) and Alice Springs region, Northern Territory (Morton and James 1988).

South Australian chenopod shrublands have been grazed extensively by sheep, cattle and rabbits for over a century (Williiams and Oxley, 1979). Grazing reduces both the plant cover and species richness of shrublands and causes soil compaction and erosion (Lay 1979, Marshall 1973). These factors obviously affect the natural biota of the fragile semi-arid regions, hampering efforts to understand the natural ecology of this region.

Grazing has been less intensive in the Olympic Dam Operations Mining Lease than in surrounding pastoral lands (Fatchen *et al* 1982). Grazing was restricted in the region until 1956, due to the lack of permanent water, and since 1986 stock have been completely excluded from the mine lease. The vegetation of the study site has not been affected by the mining operation (T.J.Fatchen pers. comm.), even though the mine is less than one kilometre away, and hence the fauna at the site of this study would be similar to that of an undisturbed habitat.

This paper documents the herpetofauna evicted from a chenopod shrubland swale at Roxby Downs by a natural flooding event.

Reptiles in chenopod shrublands retreat to burrows to avoid temperature extremes, escape from predators and lay eggs. Therefore studies of reptile assemblages in this habitat type, along with many other habitats, requires a technique which either traps reptiles in an unbiased fashion while they are active on the surface, or alternatively entices or forces all reptiles from concealment.

Pit-falling is a commonly used method of surveying reptile assemblages in the arid zone and this technique has the advantage over opportunistic searching (eg. Pianka 1986) in that cryptic and fossorial species are recorded without bias (Morton and James 1988). However, the establishment of pitfall lines is a labour intensive operation and relies on long term studies of marked individuals to determine population parameters. Severe habitat disturbance by burning and bulldozing defined regions (Heatwole and Butler 1988) is less labour intensive than pitfalling and enables rapid and accurate estimates of population densities, community stucture and biomass. However, destructive techniques such as this are generally not a satisfactory option for chenopod shrublands because they do not burn well and regenerate slowly after disturbance.

An alternative stimulus for evicting reptiles from their burrows in chenopod shrublands is flooding. Water penetrates deeper into burrows than does the heat from fires and plants benefit from the inundation rather than being destroyed. The water also cools the reptiles, thus slowing them down and facillitating their easy capture.

METHODS

On March 13 and 14 1989, 204.5mm of rain fell at Roxby Downs (30°27 N, 136° 54 E) in the mid-north of South Australia (Fig.1). Such a phenomenal rainfall event has a major impact on the enviroment in this semi-arid region which has an average annual rainfall of only 180mm. Due to the lack of any river system,local drainage rapidly floods claypans and low-lying interdunal regions, drowning some of the reptiles and forcing the survivors to flee to dunes or raised ground.

At 11 o'clock on the morning of March 14, as the rain was ceasing and the floodwaters had reached their peak, an accumulation of cold inactive reptiles was noticed on an elevated 130mm stretch of road across a chenopod swale. These reptiles had been displaced from a flooded region approximately 2.3ha in area which was bordered by sand dunes on the south and eastern sides, raised ground to the west and a road to the north. All of the shrubs, predominantly *Atriplex vesicaria, Maireana astrotricha and Maireana aphylla* were submerged and there were no trees in the flooded region to provide refuge for the reptiles. A strong southerly wind (windspeed 9.3m/s, wind direction 162°), measured at a weather station one km away, had blown nearly all live and drowned reptiles to the edge of the flood waters on the road.

All live reptiles were rescued from the road and identified, measured and weighed before being released in the same swale adjacent to the flooded region. Not all dead animals were collected but were conservatively estimated to be about half as numerous as live specimens and represented a similar species mix to those collected. All but one species, namely *Ramphotyphlops bituberculatus* present on the road were represented by live specimens.

The rescued reptiles were categorised as adults (reproductively mature), subadults or juveniles. Snout-vent lengths of sexually mature animals registered in the Olympic Dam Operations fauna database, which had been captured in the summer breeding season, were used as a guide to classify these reptiles, as they were not in breeding condition. Adult sizes given by Cogger (1986) were used to arbitrarily categorise poorly known species such as blind snakes.

RESULTS

A total of 142 reptiles from from 14 species were recorded from the 2.3 hectare flooded region. Table 1. lists the number of individuals in each age class of each species. Given that there were probably at least 70 drowned reptiles which were not collected, a density of approximately 91 reptiles per hectare was recorded. A reptile biomass of approximately 1650gms per hectare was calculated (Table 1.)

Skinks were the dominant reptile family recorded, making up 36.6% of the sample numerically and 80.6% of the biomass. Although not particularly abundant, the large Sleepy Lizard *(Trachydosaurus rugosus)* dominated the biomass of this family. The medium sized, fast moving Striped Skink, *Ctenotus regius*, and the small cryptic Grey's Skink, *Menetia greyii*, were the second and third most abundant reptile sampled respectively. Of the skinks sampled, 59% were immature.

Three dragon species constituted 38% of the reptiles recovered and attained a density of 23 individuals per hectare. The Central Netted Dragon *(Ctenophorus nuchalis)* was the most common reptile recovered and along with the small earless dragons *(Tympanocryptis spp.)* made up 16.2% of the reptile biomass. Immature dragons were three times as abundant as adults.

Geckoes made up approximately 22% of the numbers and 3.1% of the biomass of the reptiles sampled. Unlike the skinks and dragons the five species of geckoes coexisted in similar numbers. Adult and immature geckoes were equally abundant in the sample.

Blind snakes represented 3.5% of the numbers and 0.1% of the biomass of the reptiles recorded. The specimen of *R.bituberculatus* was the first record of this species from the Olympic Dam area. An additional specimen of this species was caught in December, 1989. All of the blind snakes captured were immature.

DISCUSSION

The true density of reptiles at Roxby Downs is almost certainly greater than the figure of 91 per square kilometre, as estimated in this study. Some individuals, especially of large species such as Mulga Snakes *Pseudechis australis*, Western Brown Snakes *Pseudonaja nuchalis*, Goulds Goannas *Varanus gouldii*, Bearded Dragons *Pogona vitticeps* and Western Blue-tongues *Tiliqua occipitalis* which are residents or transitory occupants of chenopod shrublands around Roxby Downs, would probably have been able to swim to safety or leave the roadside and hence avoid capture. Small species such as Grey's Skink *Menetia greyii* and juveniles of larger species may have been concealed in the considerable quantity of debris which was also washed up on the road. In addition some reptiles may have drowned in their burrows and not floated to the surface and been blown to the road.

Absence of some of the larger reptiles from the sample may have considerably reduced the estimated biomass for the region. The figure of 1650g/ha calculated from this sample is just over half of the two other estimates of reptile biomass in Australia which are approximately 3000g/ha (Heatwole and Butler 1981, Morton and James 1988). However the other estimates were calculated in spinifex grassland, which is recognised as having the most diverse lizard fauna of any habitat in the world (Pianka 1986). It is therefore not surprising that the productivity of the chenopod shrubland is lower than that of these other estimates.

Ctenophorus nuchalis and Ctenotus regius are both medium sized non specialist feeders (Pianka and Pianka 1971, Cogger 1986) which were more abundant than smaller dragons and skinks respectively. Whether this apparent dominance of medium sized species is a true reflection of their natural abundance, or a function of the sampling method, is not known.

Five gecko species, of which four are congeneric, were all able to co-exist at moderate densities due to their different dietary niches. *Diplodactylus conspicillatus* is an obligate termite feeder, *D.stenodactylus* forages predominantly on bugs, ants and spiders, *D.damaeus* includes a large beetle and grasshopper component in its diet whereas *Nephrurus levis* is a more generalised feeder eating spiders, scorpions, centipedes, grasshoppers, beetles and insect larvae (Pianka and Pianka 1976, Pianka 1986). The feeding habits of *D.tessellatus* are not known. Interestingly, another common gecko species in the Roxby Downs region *Rhynchoedura ornata* was not found in this swale. *R.ornata* is also an obligate termite feeder (Pianka and Pianka 1976) and is possibly displaced to the sand dunes by the larger *D.conspicillatus* which dwells in burrows excavated by spiders in the heavy soil of swales.

All of the reptile families were well represented with juvenile or sub-adults as well as specimens close to, or exceeding, the average adult sizes given by Cogger (1986). This fact, along with other studies conducted by Olympic Dams Operations (O.D.P. 1989) suggest that the mining operation, centered only one kilometre from the study site, has not had a deleterious impact in the environment.

The authors hope that this trial study will encourage other workers to realise the potential of similar flooding events for ecological studies. Opportunistic meticulous collecting accompanied by accurate measurements will greatly contribute to the understanding of the herpetofauna of a region with very little effort or damage to the environment.

ACKNOWLEDGEMENTS

The field work for this study was carried out as part of the Environmental Monitoring Programme at the Olympic Dam Mine. Several people assisted with the field work and in the preparation of this paper. Marija Cekic and Jonas Ball brought the presence of the animals on the roadway to the attention of FJB. David Whiting assisted in the collection and initial sorting of the reptiles. Shane Badman assisted with the measuring and weighing of the animals. Tim Fatchen and Noelene Wotton helped with the securing of reference material. Robert Scott prepared Figure 1.

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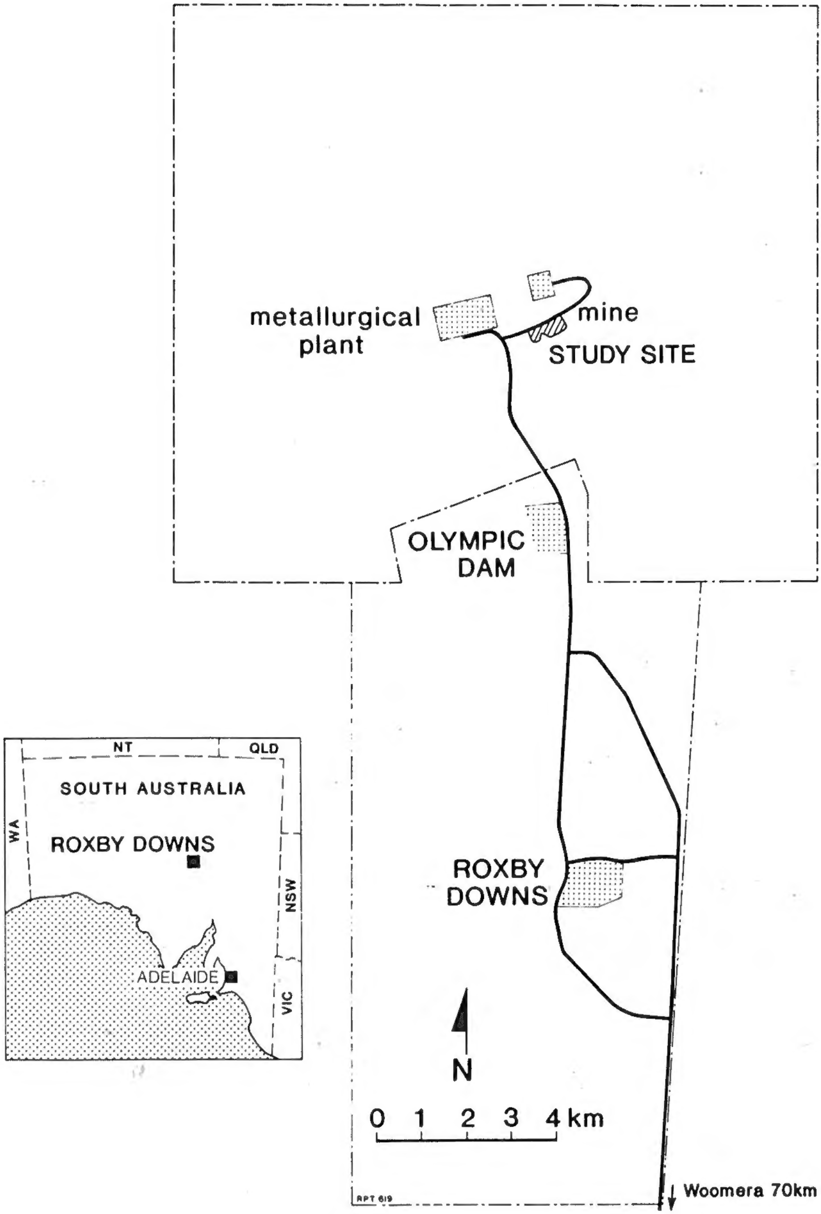

Figure 1 Location of Roxby Downs and Flooded Swale Study Site

TABLE 1. Reptiles Collected from a Flooded Swale at Roxby Downs South Australia.

SPECIES	SIZE CLASS (mm)	NO.	AVERAGE WEIGHT (g)	TOTAL WEIGHT (g)
Geckonidae				
Diplodactylus conspicillatus	A > 49	3	4.2	12.6
22: (27-59)	SA 40-49	1	4.2	4.2
	J < 40	7	1.1	7.7
Diplodactylus damaeus	A > 40	5	2.3	11.5
113: (29-56)	SA 35-40	1	1.4	1.4
	J < 35	0	0	0
Diplodactylus stenodactylus	A > 40	4	3.2	12.7
77: (28-54)	SA 35-40	0	0	0
	J < 35	2	0.8	1.6
Diplodactylus tesselatus	A > 40	4	2.9	11.7
13: (30-53)	SA 35-40	0	0	0
	J < 35	0	0	0
Nephrurus levis	A > 80	0	0	0
46: (43-93)	SA 51-80	1	4.2	4.2
	J < 51	3	3.5	10.5
Agamidae				
Ctenophorus nuchalis	A > 60	11	23.4	257.4
96: (33-114)	SA 45-60	11	5.5	60.5
	J < 45	18	2.7	48.6
Tympanocryptis lineata	A > 44	0	0	0
33: (22-50)	SA 30-44	8	2.8	22.4
	J < 30	2	0.9	1.8
Tympanocryptis intima	A > 49	2	5.2	10.4
13: (24-59)	SA 40-49	2	4.6	9.2
	J < 40	0	0	0
Scincidae				
Ctenotus regius	A > 60	8	7.1	56.8
98: (28-72)	SA 40-60	5	2.5	12.5
	J < 40	7	0.9	6.3
Lerista labialis	A > 55	0	0	0
41: (27-59)	SA 30-55	1	1.0	1.0
	J < 30	0	0	0
Mentia greyii	A > 30	12	0.5	6.0
54: (14-61)	SA 21-30	15	0.3	4.5
	J < 21	1	0.1	0.1
Typhlopidae				
Ramphotyphlops bituberculatus	A > 280	0	0	0
2: (242-270)	SA 200-280	1	4.8	4.8
	J < 200	0	0	0
Ramphotyphlops endoterus	A > 250	0	0	0
14: (100-323)	SA 200-250	2	3.6	7.2
	J < 200	2	1.0	2.0

Figures in brackets represent the range of snout-vent lengths for all reptiles recorded at Roxby Downs from 1986 to 1989, and are preceded by the sample size in bold font.
Size classes are based on snout-vent lengths.
(A=Adult, SA=Sub-adult, J=Juvenile)

RATTUS RATTUS: THE INTRODUCED BLACK RAT, A SUCCESSFUL PREDATOR ON THE INTRODUCED CANE TOAD *BUFO MARINUS* IN NORTHERN NEW SOUTH WALES.

by Mark Fitzgerald, PO Box 237, Mullumbimby NSW 2482.

ABSTRACT

The introduced Cane Toad, *Bufo marinus* is widely reported to have a deleterious impact on Australia's indigenous fauna (Covacevich & Archer 1975). Some native carnivores reputedly eat this toxic amphibian with no apparent ill-effects (e.g., Crocodiles, tortoises, freshwater crayfish) however many other native carnivores (e.g. Varanid lizards and Elapid snakes) appear to be susceptible to the toad's toxins and die after mouthing or consuming such prey.

This paper reports some records of predation upon *Bufo* by *Rattus rattus* the Black or Roof Rat, in coastal northern NSW.

INTRODUCTION

The Cane Toad *Bufo marinus* was first introduced to Australia in 1935 when numbers of toads were released in cane-growing areas of coastal north Queensland, in an attempt to control two coleopteran pests of this crop (Van Beurden 1981). Because of its high toxicity, predation upon the toad was minimal and *Bufo's* fecundity and adaptability enabled it to spread rapidly through eastern Queensland.

The present population of *B. marinus* in north-eastern NSW comprises two distinct groups; one being the southernmost edge of the expanding southern Queensland population, the other being a population apparently introduced to the Byron Bay area in 1964-66 which has spread "up to 30km" from the point of initial introduction (Van Beurden & Grigg 1980). The observed predation is reported from this isolated Byron Bay population.

Bufo occupies most habitats within its range and is particularly numerous in disturbed sites, especially agricultural areas and other areas influenced by man. *Rattus* is an abundant species within much of *Bufos* range and in the banana plantations where these observations occurred populations of both animals were conspicuous most of the time.

Evidence that *Bufo* was featuring regularly in the diet of *Rattus rattus* was presented to me in the numerous nests of *Rattus* found regularly in mature, plastic-covered banana bunches. Frequently the rats would remain within the bunch up until the de-handing process within the packing shed, thus enabling the identity of the predator to be clearly established. Remains of Bufo were very similar to each other, usually found ventral surface upward with the gular and ventral skin removed and little or no viscera remaining.

The large numbers of *Bufo* killed by motor vehicles constitute a significant food resource to those animals able to exploit this (e.g. Crows) and adventitious scavenging by *Rattus* utilising road killed toads may well occur. However the banana plantations where these *Bufo* remains are found do not produce large numbers of road killed toads since the vehicular traffic is almost solely diurnal.

Additionally during February 1988 at Ewingdale NSW I witnessed what I believe to have been attempted predation upon an adult *Bufo* by an adult *R. rattus*. Late in the afternoon my attention was drawn to a persistant rustling of dead leaves immediately adjacent to the packing shed where I was working. Upon investigation I discovered a large *Bufo* ca 125mm (snout-urostyle) emerging from beneath a basalt rock in the defensive posture utilised by these toads when threatened. The toad was presenting its broadest dorsal surface toward the rock from under which it had emerged, with the near edge of the body pressed down to the soil, with head also lowered. From beneath the rock an adult *Rattus rattus* emerged tentatively, caught sight of myself then retreated. No further activity on the rats part was observed.

DESCRIPTION OF REMAINS

The remains of three adult *Bufo* are described, as follows:

B. marinus No 1

This toad, (Fig. 1) is shown as found, somewhat stuck to the underlying green bananas. It was found on February 2nd 1989 at Mullumbimby Creek, a narrow valley in the foothills of the Nightcap Ra. (co-ordinates 28°30'S 153°30'E). Rat faeces dispersed throughout the bunch provided support for the hypothesis that this was the remains of a meal for the Black Rat, (Rattus rattus). With the remains of the toad were some grasshopper wings, (beneath and in front of the snout of the toad) and other hard insect parts. The toad was found on its back with all viscera, eyes, and most of the limbs missing. Also missing was much of the ventral skin, including all the skin from the gular and pectoral areas, and some of the skin from the lower legs. Dorsally (Fig. 2) most of the skin remained with both parotid glands intact, and all skin on the head remaining but for both eyelids on the left eye. The lower edges of the parotid glands were clearly defined as all ventral skin up to their margins had been removed.

The remains of this toad measured 87mm from snout to urostyle, desiccation having produced a somewhat bowed effect. The base of the head measured 38mm across. The interior of the body cavity is devoid of flesh, perhaps because of dermestid beetles or fly larvae feeding on the carcass after the rat had completed its consumption of the toad. However, some ribs and the femur (?) can be seen to have been fractured and perhaps gnawed (Fig. 3).

B. marinus No 2

This toad was found with ventral surface upward on the coastal plain west of Byron Bay at Ewingsdale NSW (co-ordinates 28°30'S 153°30'E) in a working banana plantation. The remains measure about 90mm from snout to urostyle and about 38mm across the base of the head. The viscera have been entirely removed and one hind foot is missing. This is an older more weathered specimen with some earth lodged in places in the skeleton and most of the skin missing. Skin remains however on the entire left and right hind feet, around the upper jaw and over one eye. The parotid glands are intact and there is a strand of gular skin remaining. The lower right hand jaw remains.

B. marinus No 3

This skeleton is in pieces so overall length cannot be accurately measured, but since the base of the jaw is about 45mm across the toad was probably around 100mm in length. Found over about 60cm this skeleton appears to have been scattered by moving groundwater. The head was found ventral surface upward. In this skull the lower jaw bone is present, covered with skin, but separated at the forward apex or "chin". Much of the gular skin has been removed with a strand 4-6mm in width remaining across the base of the jaws. The entire right leg remains with intact skin as does the lower right forearm partly covered with skin. A strip of dried dark dorsal skin and a small patch of lightly pigmented ventral skin remain, the latter measuring about 18 x 10mm. The parotid glands are intact.

DISCUSSION

The present extensive range of *B. marinus* (Fig 4) presents maximal opportunities for interaction to occur with a wide range of Australian fauna. Records in the literature describe numerous species as having preyed upon *Bufo*. Table 1 includes a list of predators recorded as having fed upon *Bufo* marinus and survived. Table 2 lists those animals recorded having died after mouthing or ingesting *B. marinus*.

From the above records it can be seen that *Rattus rattus* is recorded in both categories; as a successful predator upon *B. marinus* and also as a casualty from ingesting the toad.

The observations on *B. marinus* being utilised as a regular food source by *Rattus rattus* contained in this paper took place in areas where *Bufo* had been present for at least 12 years (Mullumbimby Creek) and up to 20 years (Ewingsdale). The *Rattus* populations here are probably as old as European occupation in the area. It will be

useful to investigate whether *R. rattus* unfamiliar with *B. marinus* are equally as able to exploit this dietary resource, and whether populations of *R. rattus* which are able to utilise *Bufo*, exhibit higher dose-related tolerances to *Bufotoxins*. *B. marinus* once common in an area, provides a food resource of great significance to an animal able to safely utilise this resource. In the Mullumbimby / Byron Bay area *R. rattus*, the introduced Black Rat, appears to have learnt how to kill adult Cane Toads and transport these dead toads up to 3.5m above ground to their arboreal nests where the prey is consumed in safety and at leisure.

ACKNOWLEDGEMENTS

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TABLE 1

Species	Common name	Source
Hydromys chrysogaster	Eastern Water Rat	Covacevich & Archer, (1975)
Rattus rattus	Black Rat	Adams, (1967)
Candoia spp.	Boa	Gorham, (1968)
Varanus salvator	Salvadors Monitor	Zug, Lindgren & Pippet, (1975)
Tropidonophis mairii	Freshwater Snake	" " "
Crocodylus spp.	Crocodile	" " "
Kuhlia rupestris	Jungle Perch	Covacevich & Archer, (1975)
Podargus strigoides	Tawny Frogmouth	Filmer, (1974)
Eudynamys scolopacea	Koel	Cassels, (1970)
Corvus spp.	Crows	Frauca, (1974)
Dendrelaphis punctulatus	Tree Snake	Covacevich & Archer, (1975)
Rattus ?		Lutz, (1968)

TABLE 2

Species	Common Name	Source
Egernia major	Land Mullet	Covacevich & Archer, (1975)
Varanus gouldii	Goulds Monitor	Stammer, (1981)
" "	"	Van Beurden, (1980)
Stegonotus cucullatus	Slatey-grey Snake	Covacevich & Archer, (1975)
Boiga irregularis	Brown Tree Snake	" "
Pseudechis porphyriacus	Red-bellied Black Snake	" "
Acanthophis antarcticus	Death Adder	" "
Pseudonaja textilis	Common Brown Snake	" "
Notechis scutatus	Tiger Snake	" "
Corvus spp	Crows	" "
Dacelo gigas	Kookaburra	" "
" "	"	Van Beurden, (1980)
Ixobrychus minutus	Little Bittern	" "
Dupetor flavicollis	Black Bittern	" "
Dasyurus geoffroyi	Western Native Cat	Covacevich & Archer, (1975)
Sarcophilus harrisi	Tasmanian Devil	" "

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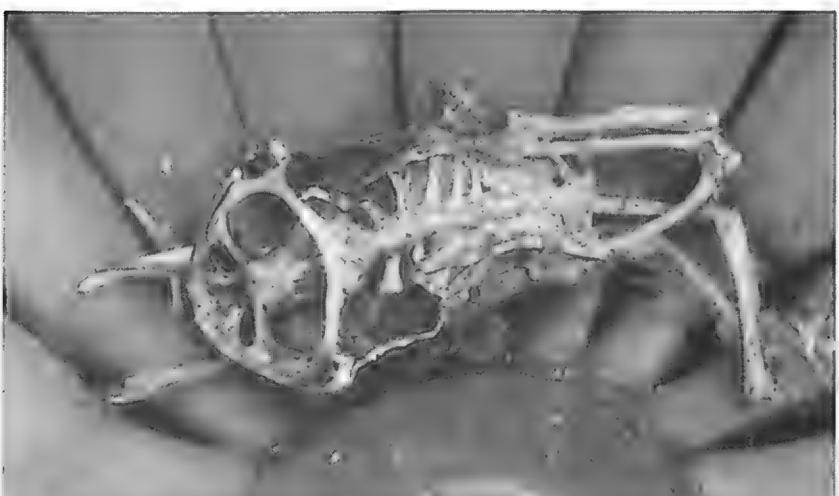

Figure 1: Remains of *Bufo marinus* as found in banana bunch.

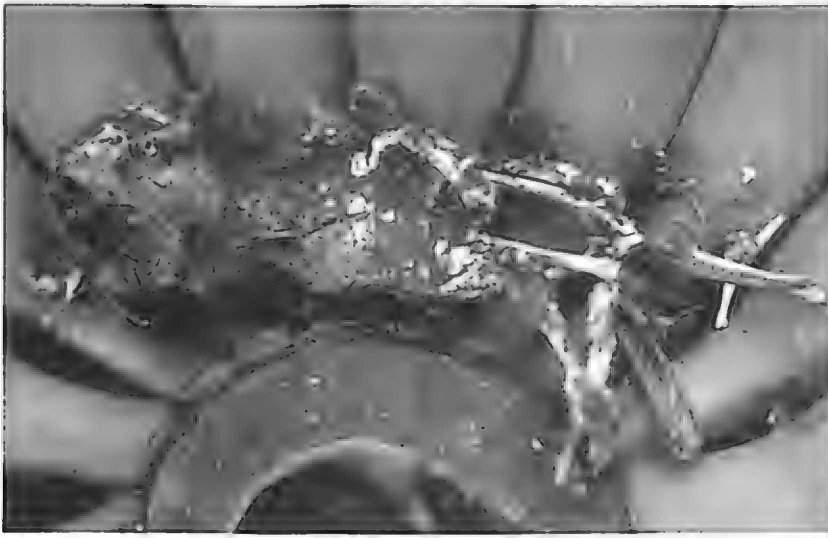

Figure 2: Dorsal aspect of the remains.

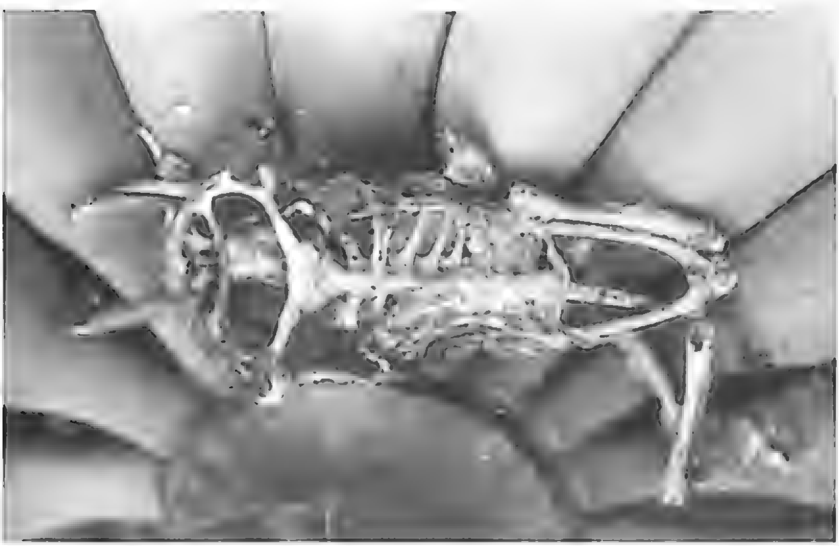

Figure 3: Ventral aspect showing the fractured bones.

Figure 4: Distribution of: A - *Bufo marinus*
B - *Rattus rattus*

A RECORD OF PREDATION ON *NEPHRURUS LEVIS* BY *PSEUDONAJA NUCHALIS*

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An adult *Pseudonaja nuchalis* was observed attempting to consume an adult male *Nephrurus levis* on January 3, 1986 at 10:00 hours.

LOCATION

The site is located in Western NSW, close to the Warrego River (see fig.1).

HABITAT

This location has a variety of different habitats in close proximity.

1. The Warrego River flood plain is grey silt and clay with a cover of blue bush, bimble box, ironwood and grasses.
2. Plains of heavy red soil covered with mulga, gidgee, other acacias and turpentine.
3. Red sand dunes covered with callitris, chenopod shrubs, acacias and grasses.
4. Stoney gibber ridges covered with acacias and some copperburr.

OBSERVATION

On a morning sweep through the dunes we observed a *Pseudonaja nuchalis* which we initially assumed to be dead, as it made no movement at our approach. A closer examination showed that the snake was in the process of trying to swallow a *Nephrurus levis*. The snake had managed to engulf the gecko's head, but appeared unable to proceed further at that stage. The gecko had inflated its body and was showing no sign of being subdued by the snake venom, though the disparity in size and weight made struggle difficult for the gecko.

We followed the snakes trail back for a couple of metres to an open burrow typical of the type dug by *Nephrurus*. The snake sign showed that it had come across the burrow whilst moving over the dunes, penetrated it to some degree, (presumably with its head) then moved on in an erratic manner to its present location.

For some 20 minutes we continued to watch both animals. Even though ants were crawling over its head and into its mouth, the snake rarely moved. On the other hand the gecko continued with vigorous, though occasional, threat displays. After taking photos we moved off to complete our morning rounds. We returned an hour later to find that the snake had moved under the dense cover of fallen dead shrub. No further observations were possible so we continued back to camp.

DISCUSSION

Some interesting questions are raised by our observation of this incident. How did this diurnal snake capture a nocturnal gecko?

1. Was the gecko captured after it returned to its burrow but before it was able to plug the entrance with sand as these animals invariably do? If so the snake would have to be foraging well before dawn, (Pianka 1976) and the gecko had demonstrated a strong resistance to *P.nuchalis* venom, as the snake would have been struggling with the gecko for a minimum of four hours.

2. Did the snake, during its morning foraging across the dunes locate a retreat inhabited by *N. levis*, sense its presence underground, push through an extensive sand plug, and grab the gecko inside the narrow confines of the tunnel? If so *P.nuchalis* has a remarkable ability to locate subterranean prey.

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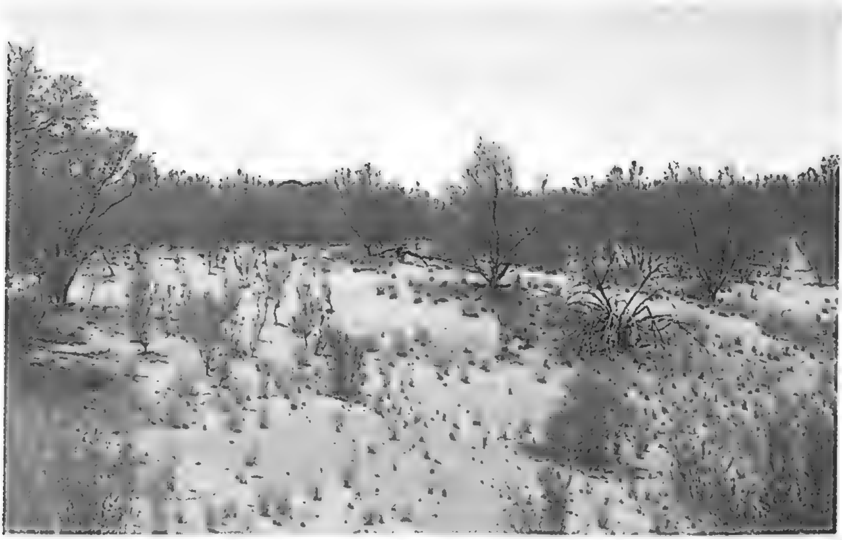

Figure 1. Area in which the observation was made.

Figure 2. *P.nuchalis* with *N.levis*

FURTHER NOTES ON CAPTIVE BREEDING OF *LITORIA INFRAFRENATA* (ANURA: HYLIDAE)

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INTRODUCTION

The Giant Tree Frog *Litoria infrafrenata* (Gunther) was bred in captivity in the Royal Melbourne Zoo in 1981 (Banks *et al.*, 1983). That breeding provided basic information about the reproductive biology of this species and provided further comparative data on the life histories of Australian hylids.

More recent breedings, some involving specimens reared from the 1981 breeding, were achieved from 1988-90. These provided data on breeding behaviour, the early developmental stages, and on the influence of a range of rearing techniques on growth and development of lavae.

The study began February 1988, when the Zoo's collection comprised a pair of adult frogs and two adults of unknown sex. A further three adults were received as public donations during the study period, which ended in March, 1990.

MATERIALS AND METHODS

With the exception of one display enclosure, all tadpoles and adult and juvenile frogs were maintained in an off-limit area (R05) in glass aquaria of three sizes - A: 20cm long x 15cm wide x 15cm high, B: 60 x 30 x 30cm and C: 90 x 37 x 45cm. Tanks containing frogs were covered with wood-framed wire mesh lids. Enclosures contained one or two rocks on the bottom and, for frogs, one or two branches positioned diagonally from one lower corner to the opposite upper corner. Tap water at 23-26°C was used directly from the mains supply at all times. Water depth was 8-12cm.

The display enclosure (RD36) was a large exhibit measuring 1.8m long, 0.8m deep and 1.5m high. The frogs occupy the upper 60cm, the lower 90cm displaying Arafuran File Snakes *(Acrochordus arafurae)* and Jardine River Rainbow Fish *(Melanotaenia macculochi)* (Harcourt, 1989). The "frog's region" was naturally landscaped with branches, vines and live plants, and was lit naturally as well as by an overhead True-lite fluorescent, the latter being on between 08:00 and 17:00 hours. Hence, photoperiod was essentially that for Melbourne. Temperatures ranged from 23-32°C.

Frog and tadpole measurements were taken with vernier calipers measuring to 1mm, and specimens were weighed on a 0.1g graduated triple-beam balance.

Tadpoles were fed daily or on alternate days with crushed endive, Tetramin flake fish food and, occasionally Aquarium Vegie-mix. They also commenced grazing on algae on the submerged rocks, and sides and floors of the tanks, from about 10 days of age. Newly metamorphosed froglets were fed houseflies and, later, small crickets *(Teleogryllus oceanicus)*. Adult frogs were fed adult crickets and chopped mice, usually individually offered on forceps.

Calling, amplexus and oviposition occurred in two tanks - the display enclosure RD36 and a size B holding tank. The specimens in this holding tank were transferred to a size C holding tank during the study period.

RESULTS

Adult size: snout-vent lengths and body weights of adult frogs are given in Table 1.

Breeding behaviour: males called irregularly from October to March, but most often from late October - late January. Calling and spawning occurred on the same day three times, but overall there was no apparent relationship between the two events. On two recorded occasions, a male, or males, calling in RD36 seemed to stimulate calling by male(s) in R05 (7m distant). Calling occurred most often in the mornings, from 08:00 - 10:30 hours.

Amplexus is axillary and was observed on eight occasions. One instance involving three males was also recorded - a pair in amplexus together with an additional attached male was observed at 09:00 hours on October 9, 1989. Over a period of 15 minutes the three frogs moved from a low branch to a rock at the surface of the water, at which point a third male attempted to join the group. This lasted for a further 10 minutes, with the third and second male eventually becoming dislodged in the water. The third male then jumped onto a nearby branch, very close to a fourth male, which was calling. As these two frogs encountered each other, the fourth frog appeared to push the third male away with its forefeet, causing both to fall into the water. This activity was repeated as they climbed onto a rock, with the third male eventually jumping away. Neither specimen called during this encounter.

Eggs: 24 spawnings occurred during the study period - four in RD36 and 20 in R05: 2 in October, 4 in November, 5 in December, 3 in January, 5 in February, 4 in March, and 1 in May. Spawning usually occurred 36-72 hours after some or all of the water in the frogs' tanks had been changed. In most cases, actual deposition of the eggs was not seen and the eggs were found from 1-15 hours after oviposition. Clutch sizes were visually estimated at 300-800 eggs.

Eight of the later spawnings allowed more accurate estimation of egg numbers. In the first of these spawnings, a pair of frogs was found in amplexus in R05 on the morning of 17 November 1989. As the female (body length 101mm) released the eggs, the male appeared to draw them up with his hind legs, presumably to fertilise them, before releasing them into the water. This activity resulted in each clump of spawn assuming a dumbbell shape having overall dimensions of 60mm length and 30mm width (Fig.1). A total of 36 clumps were laid, each containing approximately 80 eggs for a clutch size of approximately 2900 eggs. Prior to emergence of the tadpoles, the clumps expanded to a maximum length of 70-80mm and a maximum width of 40-45mm. However, the dumbbell shape was retained.

In spawning in tanks with greater water movement, the clumps were usually broken up against submerged branches, etc. The mean estimated clutch size for all eight clutches was about 2000 eggs (1500-2900). Eggs in a clutch laid in March 1990 were counted, for a total of 4187 (visual estimate about 2500). However, this was a single mass of eggs, not distinct clumps.

Deposition of the first clutch in the study period (16 February, 1988) was observed. During amplexus and spawning, the male moved back and forth on the female's back. The eggs were released in long strings and their upper surfaces were black or white. The clutch, of approximately 700 eggs, was checked visually on four occasions over the 90 minutes following completion of laying, during which all eggs rotated so that black surfaces were uppermost.

This clutch was laid in 25mm of water, with a water temperature of 24°C at the time of oviposition. The male called for 10-15 seconds after releasing the female. Diameter of egg capsules was as given by Banks et. al. (1983). In the 1981 study no movement was seen during amplexus and no dumbbell shaped clumps were recorded (Banks et. al.,1983).

Embryos: water temperature for the first clutch (deposited 16 Febrary 1988) varied from 24-30°C over the first eight hours, and 23-28°C over the second day. Twenty four hours after deposition, the embryos had become noticeably elongate and little remained of the white yolk-sac. By 32 hours, the embryos had adopted a tilted, head-up position and they were moving slightly within their egg capsules. All had hatched by 08:00 hours the following morning - a maximum period of 48 hours after oviposition. A similar period was noted for other clutches where time of oviposition was known.

Larvae: apart from one series of measurements taken at one day of age (mean, body length 3.2mm [2.5-3.7, n=5]; mean total length 5.1mm [4.6-5.8 N=5]), no measurements were taken of developmental stages, but external morphology and development appeared to follow that given by Banks *et.al.* (1983); ie. external gills prominent in embryos, general colour of embryos and larvae dark brown, creamy-white lateral stripes developed at 5-10 days and changed to silvery-orange at 25-35 days. The spiracle was ventrolateral, dorsal fin well-arched and the tail tapered to an acuminate tip.

About 600 tadpoles from the first clutch were divided, approximately equally, into three size C aquaria on the day they hatched. Water depth in these tanks was 10cm, and each was provided with an air-stone, water weed and two small rocks. They were then placed on a heated concrete table on pieces of 19mm polystyrene, to prevent the water overheating. Water temperature over the following week ranged from 20-28°C in the mornings to 24-28°C in the afternoons.

All tadpoles from one tank were transferred to the Zoo's Education Service, seven days after hatching for rearing in the Service's classrooms, leaving two size C tanks and about 400 tadpoles in the Reptile House. During the 15 days following hatching, three additional size A tanks were established - No.1: six tadpoles transferred two days after hatching: No.2: eight tadpoles transferred 13 days after hatching; and No.3: 15 tadpoles transferred 13 days after hatching. All tanks maintained water temperature of 20-27°C. The two size C tanks were not cleaned for the first two weeks and from then on were cleaned once or twice weekly, and stayed quite clean.

The three size A tanks were not cleaned for the first 10 days and became very dirty. However, the tadpoles appeared to thrive. For the rest of the tadpole stage both sets of tanks were cleaned every 6-8 days.

The tadpole's rate of development varied between the A-sized tanks:

...back legs first appearing: tank 1 - 30 days post hatching, tank 2 - 36 days, tank 3 - 34 days;
...front legs first appearing: tank 1 - 44 days, tank 2 - 47 days, tank 3 - 47 days. The day prior to all "external appearance" of front legs, tadpoles had developed slight swellings, from which legs erupted the following day. The front legs could also be seen moving prior to eruption;
...tail totally absorbed: all tanks: 49-51 days.

Although no length measurements were taken, the tadpoles in the size C tanks were smaller than those in the A tanks at the stage of back leg development. Metamorphosis for tadpoles in the C-sized tanks was completed after 93 days.

Cannibalism was noted during the tadpole and froglet stages of the first clutch, and tadpoles were seen eating both live and dead tadpoles, as well as recently dead metamorphosing froglets. Overall tadpole mortality in this clutch was 62% and 220 froglets metamorphosed. Tadpole mortality in other clutches remaining in the Reptile House was 41%.

A group of tadpoles, from eggs laid 30 November, 1988, started to develop back legs after 22 days and completed metamorphosis after 30 days. These were maintained in water at 24-27°C, and the slight increase in temperature appeared to accelerate development.

Post-metamorphic growth: the young frogs commenced feeding on live house flies and small live crickets within five days of completing metamorphosis (ie. 54-56 days post-hatching) and began accepting live crickets from forceps after a further 10-20 days (64-76 days post-hatching). Over the following three months, 28% of all froglets from the first clutch died, primarily from cannibalism and a failure to thrive. In addition, 25 were sent to Adelaide Zoo and 64 to the Northern Regional Centre (Townsville) of the Queensland National Parks and Wildlife Service, in August 1988, for subsequent release in appropriate national parks. Twenty frogs were retained by the Zoo and 12 were placed on exhibit in RD36 on 17 August. These specimens had a mean snout-vent length of 45mm on 20 September 1988. Although most have thrived, two have since developed swellings over their pelvic regions.

Spawn from other clutches was either not allowed to develop or was fed to small freshwater fish and tortoises.

Frogs which metamorphosed in the Zoo on 15-20 May 1988, first spawned on 30 March 1989 in RD36 (Table 1.).

DISCUSSION

Times of calling, amplexus, early clutch size, size of egg capsules and larval life-span were similar to those previously recorded (Banks *et.al.,*1983). However, length of larval life-span was shown to be influenced by temperature, ie. 49-51 days at 20-27°C and 30 days at 24-27°C. Clutch size varied greatly and the count of all eggs in one clutch, over 4000 (compared with a visual estimate of 2500), indicated that visual estimates of clutch size were too low. Apart from *Bufo Marinus* only *Cyclorana australis* is recorded as having a larger clutch size than *L. infrafrenata* (Tyler, 1989).

No reference to the distinctive dumbbell shape of some spawn clumps has been found, although *Litoria bicolor, L.phyllochroa, L.latopalmata and L.ewingi* are recorded as depositing eggs in small clumps (Barker and Grigg, 1977). The myobatrachids *Taudactylus eungellensis* (Liem and Hosmer, 1973) and *Uperoleia inundata* (Tyler *et. al.,* 1983) are also known to deposit small clumps of eggs.

Tank size appeared to affect rate of larval development, although numbers of larvae may also have been a factor. However, overall the results are similar to those noted by Sokol (1984) for tadpoles of *Litoria ewingi,* ie. that tadpoles in crowded cultures had slower growth rates, longer larval periods and smaller sizes at metamorphosis than tadpoles reared at lower densities. Crowding and low temperatures during metamorphosis has been shown to lead to smaller toadlets in *Bombina variegata* from south-west Europe (Kapfberger, 1984).

The period of 10 months between metamorphosis and sexual maturity is very short for such a large frog, but the size of the frogs at maturity was similar to that recorded in the earlier paper, 75mm (65-83, n=8, this study) compared with 77mm (1983). Madej (1964) suggested that sexual maturity in *Bombina bombina* and *B.variegata* is reached after two years.

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Jon Birkett and Noel Harcourt, Reptile Department at Melbourne Zoo, assisted in the maintenance of animals and collation of data; and Angus Martin, Zoology Department at University of Melbourne, provided constructive comment on the manuscript.

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TABLE 1. Weights and snout-vent lengths of 14 *Litoria infrafrenata* at Melbourne Zoo.

(a) FROGS IN R05 - February 14, 1990

SPECIMEN	SNOUT-VENT LENGTH (mm)	WEIGHT (g)
Male	90	54.4
Male	86	54.2
Female	108	95.7
Female	101	93.6
Unknown sex	94	63.5
Unknown sex	90	56.3

(b) FROGS IN RD36 - March 30, 1989 (these frogs were siblings, metamorphosed at Melbourne Zoo on 15-20 May, 1988).

SPECIMEN	SNOUT-VENT LENGTH(mm)	WEIGHT(g)
Male	74	31.4
Male	76	31.2
Male	79	30.8
Female	83	25.9
Unknown sex	81	28.8
Unknown sex	68	20.6
Unknown sex	65	16.3
Unknown sex	72	25.5

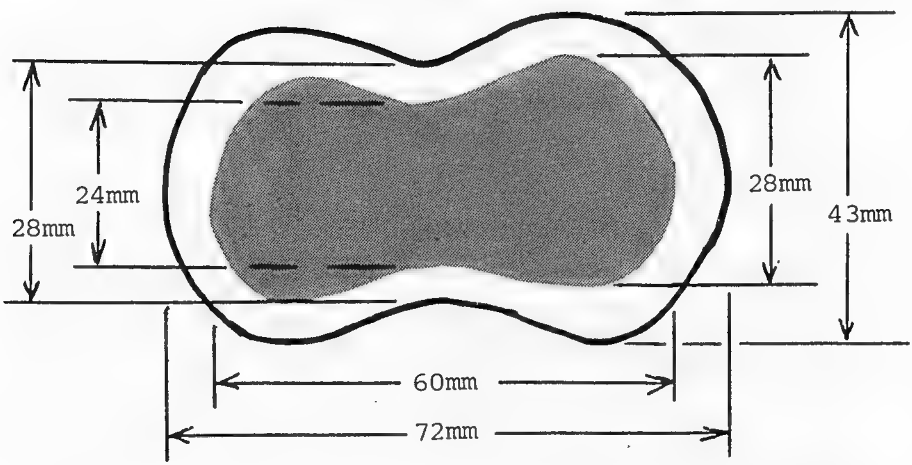

Figure 1. Dimensions of a spawn clump of *L.infrafrenata,* laid November 17 1989 (inner dimensions as at deposition; outer dimensions are maximum prior to hatching).

RANGE EXTENSION OF THE DARWIN HOUSE GECKO, *HEMIDACTYLUS FRENATUS*

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The Darwin House Gecko *Hemidactylus frenatus* is a common and well known species that occurs in the tropical regions of the far north of the Northern Territory and Queensland (Figure 1). It is an introduced species that has been recorded as early as 1840 at Port Essington on the Coburg Peninsula in the Northern Territory (Cogger & Lindner, 1974). In Queensland, on Cape York Peninsula, populations occur in and around Cairns and at Sinclair Islet (11°07'S 143°01'E) and Cockburn Island (11°50'S 143°18E) off the east coast at the tip of Cape York. *H. frenatus* is a gecko that hunts and feeds on common soft bodied flying insects that are attracted to the lights of buildings and houses and for this reason large populations have become established. It is most likely that this species was transported to Australia from the islands of the equitorial regions to the north via sea travel. Its reliance on either the presence of man or disturbed habitat is shown by its disappearance when Port Essington was abandoned in 1849. Due largely to its small size and secretive nocturnal habits this gecko can avoid detection during transportation.

The establishment of a population of *H. frenatus* at a new location deserves comment and is documented below. Observations were made during two field trips in the Northern Territory (25/12/1975 to 1/1/1976 and 9/9/1976 to 14/10/1976). At that time this species was only found as far south as Katherine and Katherine Gorge. More recently however, on two further field trips to the same region (6/11/1986 to 20/12/1986 and 13/11/1987 to 26/12/1987) this species was found as far south as Renner Springs (133°48'E 18°21'S) on the Stuart Highway, where a single individual was caught under a window curtain at the local hotel. In a more isolated region of the Northern Territory at Timber Creek (130°13'E 16°20'S) another population of *Hemidactylus frenatus* was observed at night feeding on insects attracted to lights around a few buildings (Figure 2).

Hemidactylus frenatus occurs in buildings and houses in areas where native species of similar size and habits (the Australian House Gecko *Gehyra australis* and the Dtellas *Gehyra pamela* and *Gehyra purpurascens*) inhabit sourrounding tropical woodland and rock outcrop habitats. However no individuals of *Hemidactylus frenatus* were sighted living in micro sympatry with them.

These species are the only ones similar enough to be confused with H. frenatus. Of these *Gehyra australis* is micro-sympatric with *H. frenatus* on buildings. At night in these locations both appear much the same in colouration, each adopting an almost uniform ghostly pale grey shade with little or no trace of dorsal variegations (Figures 3 & 4). In such artificial environments sympatry between these two geckos was observed several times at Cooinda, Renner Springs and the Border Store at East Alligator River, where they were found feeding on insects on light coloured walls. At a close proximity *H. frenatus* can be distinguished by its characteristic pinkish tail and rows of enlarged and protruding scales along the dorso-lateral and ventro-lateral surfaces on an original tail. When found on trees near-by, as observed at Cooinda, individuals are strongly variegated in dark grey on a light grey base colour. Five individuals of *H. frenatus* were found both at night and during the day resting on rough barked trees in a small grove at the hotel. These were well camouflaged and difficult to see (Figure 5). The more positive way to distinguish between these two species is to check the differences in the toe dilations of both species (Figure 6). The lamellae of *Gehyra australis* are broadly expanded laterally to form large sub-circular pads, and usually these are not grooved through the centre. Only four toes of both fore and hind limbs are clawed leaving the inner toe of each limb clawless. Those of *Hemidactylus frenatus* however are only moderately expanded to form slightly broadened pads, and as the generic name implies the sub digital lamellae of the toes of each

limb are strongly divided into two halves. Each toe is clawed and these arise from the upper surface near the centre.

The Darwin House Gecko *Hemidactylus frenatus* is becoming well established in settled areas on the Australian mainland in the tropical region, but it is most likely that its most southerly limit will be the Tropic of Capricorn (28°28'S). During winter months of the year temperatures drop below zero in Central Australia and are far too low for a tropical species to survive.

As a matter of interest one other exotic gecko species, *Gekko verticillatus* survived for a time at Port Essington also (Boulenger 1885). It too disappeared when this town was deserted, possibly for the same reasons as *Hemidactylus frenatus.*

ACKNOWLEDGEMENTS

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Figure 2. Distribution of the Darwin House Gecko *Hemidactylus frenatus* in the Northern Territory.

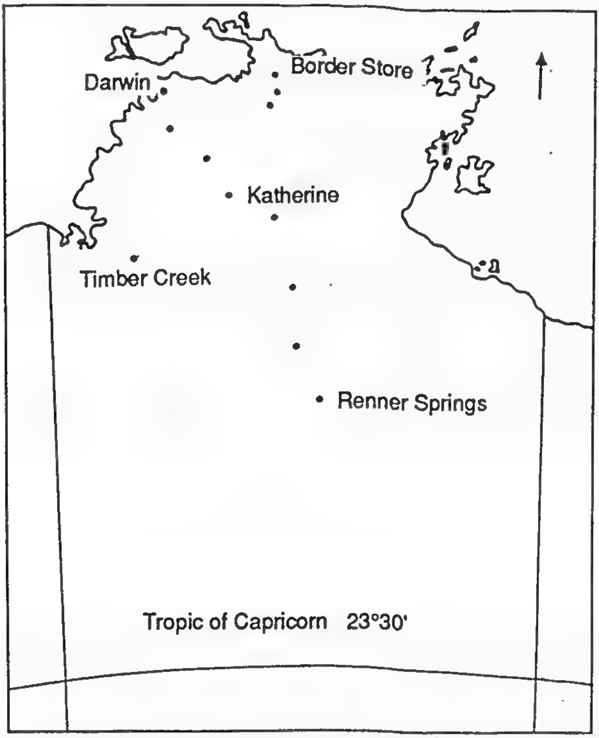
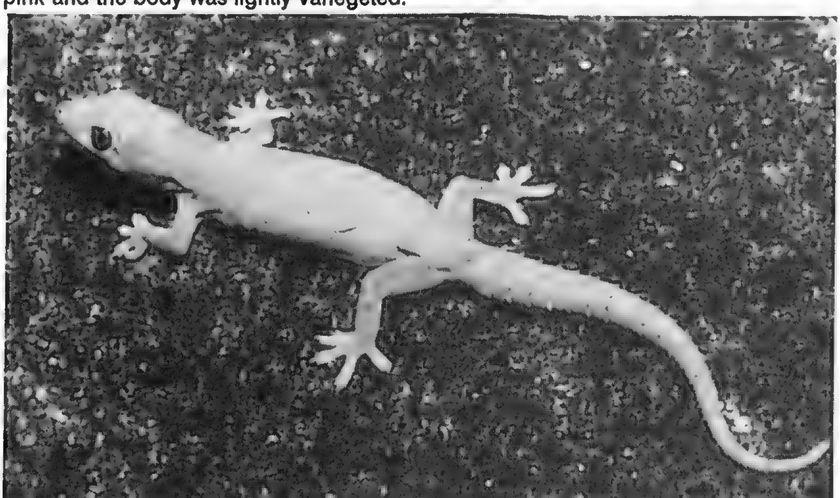


Figure 3. *Hemidactylus frenatus* removed from a building wall at Border Store N.T. This gecko was found to be almost uniform light grey. The tail was a shade of light pink and the body was lightly variegeted.



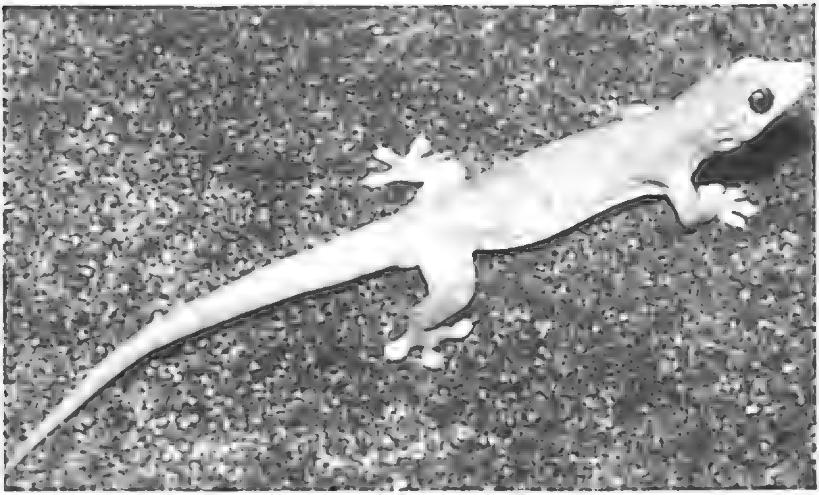


Figure 4: *Gehyra australis*. When found on the wall of a building this gecko, captured at Border Store, resembled the Darwin House Gecko *Hemidactylus frenatus* in colouration, being light grey with very pale dorsal variegations.

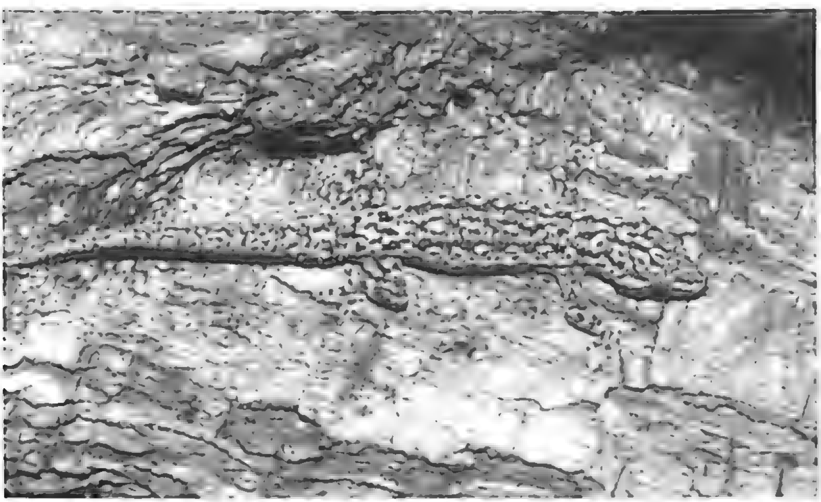


Figure 5: *Hemidactylus frenatus* photographed in life as it rested on a tree trunk at Cooinda N.T. where others were found in the same situation at 2.10pm. All were full grown adults of similar colouration. There were no loose exfoliations of bark to provide shelter but the thick foliage of the trees gave enough protection from the sun. The atmospheric temperature was recorded at 32°C while the shaded bark was 30°C.

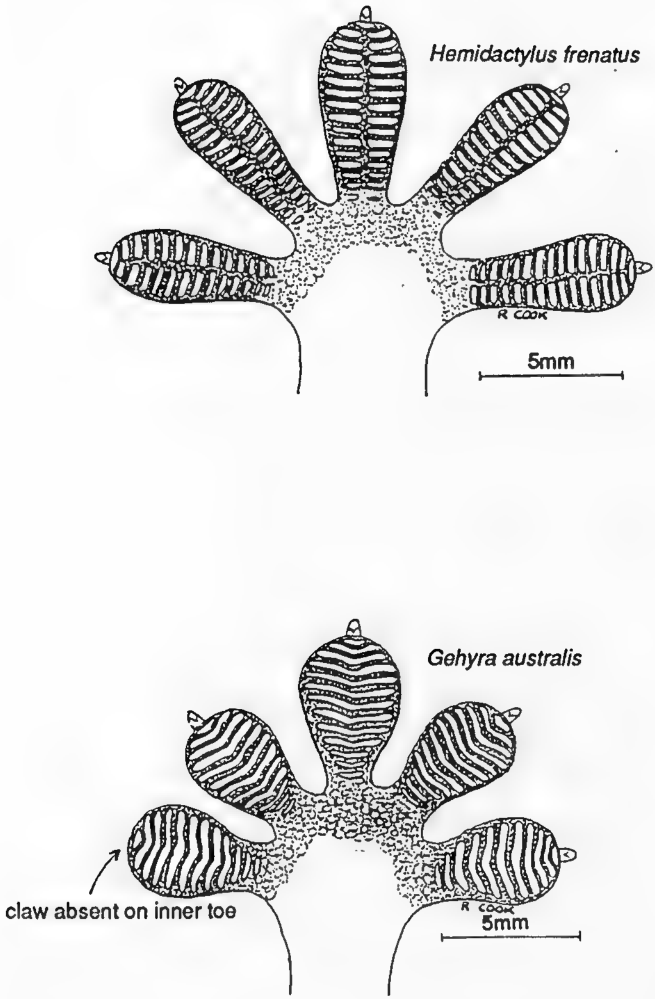


Figure 6: Left forelimb and digits of *Hemidactylus frenatus* and *Gehyra australis*.

NOTES ON THE IMPORTANCE OF WATER TO WATER SKINKS *(EULAMPRUS QUOYII)*

by Bradley S Law
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How does an animal recognize its habitat? Most animals to some extent, are capable of controlling where they will feed and breed. Their methods of doing so, however, are numerous and varied.

The eastern water skink *(Eulamprus quoyii)* is the most widely distributed species of the Water Skink complex. It is often seen diving into creeks as an escape route, sometimes staying submerged for 10 minutes (pers. obs.). This animal provides an interesting subject for studying habitat selection, for although it is commonly associated with water, it is also occasionally seen on ridges well away from free surface water (Cogger, 1986). A physiological study of water loss showed that *E. quoyii* had a long survival time and its rate of water loss was less than some dry-adapted species (Heatwole and Veron, 1977), although those tested were smaller in size and had proportionately greater surface area than water skinks. In a review of 30 lizards (Mautz, 1982), *E. quoyii* had the second lowest % vital limit (the amount of water an animal can lose before death). Law and Bradley (1990) have also shown that water skinks reduce their preferred body temperature from 29°C to 24°C, when deprived of water for 24 hours. Thus, although *E.quoyii* does not lose water at a particularly high rate, it appears to be sensitive to relatively small losses. This poses a question: are water skinks physiologically tied to moist conditions and is water a component of their habitat that they actively select?

As part of a study on basking site selection by *E.quoyii* I chose 21 sites around the Sydney area to represent a wide range of habitats, including gallery rainforest, open Hawkesbury sandstone creeks, moist rocky seepages along the coast and creeks surrounded by thick heath. Water skinks were present in higher numbers along some creekside habitats than others. Analysis of skink abundance in different habitats indicated that vegetation structure was not related to skink abundance. More important in determining the number of skinks in these habitats was the number of rocks and their substrate temperatures (ie., basking sites). (Law and Bradley, 1990).

In this habitat analysis, free-standing surface water was not a major habitat selection cue. Two sites, one at Cape Banks (Botany Bay) and one at Wolli Creek Valley (Sydney), had large numbers of water skinks, even though they were over 100m from the nearest surface water. These two sites were typically rocky, had suitable substrate temperatures and also possessed substrate moisture levels of 10-15% water. It has been shown that the Californian Sand Burrowing lizard has the ability to directly drink soil moisture if the soil contains more than seven percent water (Fusari, 1985). Could the eastern water skink also be capable of drinking soil moisture? If water skinks are in fact physiologically dependent on moisture conditions, then the presence of water skinks on only some ridges, that are superficially devoid of water, may be explained by adequate soil moistures or humidity levels in retreats or burrows.

Little is known, however, about how ectotherms respond to changes in moisture conditions. Amphibians suffer high rates of water loss and are known to select specific conditions of moisture (Spotila, 1972) and Reagan (1974) showed that the terrestrial turtle *Terrapene carolina* will also select moisture conditions independently of temperature. I know of no study that experimentally tests the response of reptiles to humidity. As a result the water skink was tested for its ability to respond to varying humidity levels.

Gradients in humidity, from 80 to 30% relative humidity, were established by placing a dish of water containing five filter paper discs and a ball of cotton wool (to increase surface area for maximum evaporation) at the end of two 20 x 220 cm runways. The "dry" end was maintained with anhydrous sodium sulphate to absorb excess moisture from the air. Each of these ends was screened off to prevent access by skinks. A dish of water was not provided for drinking, as an even gradient of moist to dry air could not be established. Room temperature was maintained at 25°C to allow normal skink activity.

The positions of skinks placed in two humidity gradients were compared to skink positions in two control runways, that had a constant level of humidity ranging from 40 to 50%. Four fresh skinks were tested for their response each day, over a four day period, so that sixteen skinks were tested in all. Positions of skinks along the four marked runways - 0 (moist) to 220 (dry) cm - were recorded half-hourly between 1000 and 1500 h. The daily mean of these positions was used as the data point for a 2-Factor ANOVA. Factor-1 compared treatments (humidity Vs control runways) and factor-2 examined the temporal effect of running the experiment over four days.

Skinks showed no preference for the "moist" or "dry" ends of the gradient, their average position being 110 $\pm$ 15cm (mean $\pm$ SE), approximately halfway along the gradient. In comparison, the average position of skinks in control runways was at 143 $\pm$ 17cm (mean $\pm$ SE). A 2-factor ANOVA showed that skinks did not behave differently on different days and that skinks in the humidity gradient were not distributed significantly differently from skinks in control runways ($p > 0.05$).

In conclusion, it appears that water skinks are insensitive to humidity levels in a laboratory situation and that surface water is not an important habitat selection cue. The importance of water or moisture to the water skink remains unclear, although the response of water skinks to soil moisture levels in sites without free-standing surface water would be an area worth pursuing.

ACKNOWLEDGEMENTS

Thanks to R. Bradley for supervision and support of this project and to R. Shine for use of his laboratory equipment, including the "modified" thermal gradient.

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REPRODUCTIVE NOTES ON THE EASTERN BLUE-TONGUE LIZARD *TILIQUA SCINCOIDES* (WHITE 1790)

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The litter size for the Eastern Blue-tongue Lizard has been reported to be between 1 and 25 by various authors (Shea 1981, and references cited therin). Also, Barnett (1950) stated that Blue-tongues have "9 or 10, up to 15 young". McPhee (1959) reported litters of "average 10 although 2 to 24"; Davey (1970) concluded "from six to twenty". McPhee (1979) again wrote that *T.scincoides* has "average broods of ten although broods of 24 have been recorded in captivity"; Jenkins and Bartell (1980) stated that the number of young may "number as many as twenty"; Griffiths (1984) asserted that the litter "usually numbers around 20" and Wilson and Knowles (1988) said from 5 to 25 young.

PERSONAL OBSERVATIONS

On 21st August 1988 a female Blue-tongue Lizard was caught on a block of land that was being cleared for building at Blaxland, NSW. The lizard was 420mm long (total length), it had a partly regenerated tail and weighed 640gms when captured.

An adult male Blue-tongue was previously caught on a building site at Penrith, NSW. It measured 350mm.

Both lizards were placed in an outdoor pit (measuring approximately 3.5 x 2.5m) constructed from a disused pool surround. Both lizards fed extremely well on egg, fruit, snails and canned dog food. No mating was observed but about 85% of the time they were not being watched.

On 28th February, at 16:45 hours, the female Blue-tongue started to release clumps of yolk which she then proceeded to consume. Three masses of yolk were released and one full term neonate appeared, five more yolk masses were expelled and then another full term lizard was born. Both of these reptiles were alive. A few more yolk masses appeared and these were consumed in part by the adult and by the juveniles.

By this time it was late evening and because of the size of the new-borns and the possibility of more young being born, the female and the two young were moved indoors to an artificially heated cage to protect them from the neighbour's cats.

The next morning, 29th February, another dead neonate was present in the cage. This individual was flattened and partially wrapped in the embryonic membrane. It is not clear whether this neonate was born dead or subsequently killed by squashing by the mother.

The measurements and weights of the two live neonates were SVL 95, 80mm tail length 35, 40mm and mass 16, 15g.

The juveniles showed no hesitation to eat on their second day and readily accepted a bit of crushed egg as well as squashed snails. The mother was also feeding the next day and no conflict was observed between adult and the young.

Two likely explanations for this low litter size are :

1. STRESS. This may have been brought about by (a) unecessary handling, (b) maladaption syndrome through captivity, (c) local domestic cats which were often chased from the enclosure. The lizard sustained no injuries but stress may have eventuated.

2. FIRST PREGNANCY. No other *T.scincoides* were known from the area where the female was caught. It may have been many years since it was last gravid. Swan (1972) with his records of litters from the same parent in consecutive years found that the litter size increases with age and although this may be coincidental, it is quite possible this is the case naturally.

A fair amount of yolk was released (about 15 masses the size of finch eggs) and one of the neonates was either dead when born or died soon after. Could this indicate that some of the young were resorbed by the mother early in the pregnancy? Wells (pers. comm) considers that some reptiles apparently gravid when collected, inexplicably fail to produce young/eggs, indicating that some form of neonatal tissue resorption may occur. This appears to be a possibility in the above case. Allen Greer (pers. com.) informed me there are slight differences in terms of the development of embryos and because of the process of natural selection there are slight differences in the structure and function of embryos. Could this mean that resorption would affect the developing embryos in different ways or on different magnitudes possibly explaining the dead neonate, two live neonates and the number of yolk masses?

Dowling and Spencock (1964) refer to a Blue-tongue that had just one offspring. This seems due to stress as the parturition occurred in the Northern Summer (July) and would have meant a break in the normal cycle for lizards.

These explanations are all equally plausible, though on the available data, one does not appear more likely than the other.

Potential embryonic resorption is an aspect of reptile reproductive biology that definitely needs further detailed investigation, but it would probably prove quite difficult to study. A collection of data, however meagre, on this subject would be a good start. If there is anyone who has experience of this phenomena, or who has kept records of the number of yolk masses released upon the birth of *Tiliqua* please send details to the author at the above address.

ACKNOWEDGEMENTS

Thanks to Richard Wells for his help with the content of this note and for some of the references. Also thanks to Allen Greer for discussion and access to museum records.

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HERPETOLOGICAL NOTES

ACCIDENTAL CANNIBALISM IN CHILDRENS PYTHONS *(LIASIS MACULOSUS).*

by Michael Maguire, 15 Boundary Street, Tivoli Qld 4305.

Accidental cannibalism in captive snakes is a problem which is under-estimated by some keepers. The following is an account of accidental cannibalism by one of my juvenile Childrens pythons.

On the 10th February 1989 I acquired a juvenile male and on the 15th March 1989 I acquired a juvenile female. The female was slightly smaller in total length and in girth. The two specimens were housed together in a terrarium measuring approximately 40cm(L) × 20cm(W) × 20cm(H). The floor was covered with newspaper and a cardboard hide box was provided. Water was available in a bowl at all times. The lid of the terrarium was constructed of pegboard which provided ventilation. The temperature inside the terrarium was kept around 25°C. The specimens settled in and no aggressive behaviour was observed.

The following food items were offered and consumed:

26 February 1989	2 skinks
26 March 1989	1 skink
27 March 1989	1 skink and 1 pink mouse
8 April 1989	2 skinks and 2 pink mice

Both snakes refused further food until the 20th May 1989 when I offered two small skinks which were left in the terrarium overnight. Next day when checking the snakes, I found that one skink had been eaten and that the larger male had eaten the smaller female. Two days later he regurgitated the half digested female.

It seems probable that both specimens started to eat the same skink with the result that the male accidently consumed the female as well as the skink. I would suggest that specimens be housed separately where possible, especially when feeding.

AQUATIC BEHAVIOUR IN *HEMIERGIS PERONII* (SCINCIDAE)

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On January 28, 1989 at 19:50 hours, at Logue Brook reservoir (Lat. 115°59' East, Long. 32°59' South) while head torching, I observed an adult *Hemiergis peronii* active near the water's edge.

After a few moments foraging on the gravel shore line, the skink entered the water and began swimming in a snake-like manner. Swimming was accomplished with ease, with slightly raised head, presumably to allow breathing. The skink's buoyancy appeared to be assisted by the surface tension effect of water. This became evident when it paused from swimming for several seconds. I followed its movement by torch light until losing sight about 5 metres from the shore. The opposite shore was at least 20 metres away.

H.peronii tends to be associated with moist conditions (Wilson & Knowles 1988) and they also mention two other species, *H.decresiensis* and *H.graciloides*, which are often associated with streams and dams. This affiliation with moist environments by members of the genus may extend to the active use of water bodies. Swimming may be a natural activity of *H.peronii* to enable a large foraging range that would otherwise be inaccessible, eg allowing easier access to both sides of a stream or pond. The specimen I observed was probably disturbed by the torch light and taking to water may serve as an escape measure from some predators.

I recorded temperatures from the site immediately after the observation and the air temperature was 16.5°C while the water temperature was 19.5°C. This species may utilise the warmer water to assist in thermoregulation, which would make nocturnal activity more efficient.

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PREDATION ON *RHINOPLOCEPHALUS MONACHUS* (SERPENTES:ELAPIDAE) BY THE REDBACK SPIDER, *LATRODECTUS MACTANS*

Paul Orange
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Kambalda East, WA 6442.

On 16 February 1990, I discovered a specimen of *Rhinoplocephalus monachus*, (total length = 129mm; snout-vent length = 114mm), entangled in the web of a Redback Spider, *Latrodectus mactans*. The web was situated inside a large shed in Kambalda East, (31°12'S, 121°40'E). At the time of the discovery, (1.45pm) the *monachus* was still alive, being capable of feeble, uncoordinated movements. It was removed from the web at this time, as was the spider, which was located in its retreat. Both were retained for further examination.

Upon examination, at 6.10pm the same day, the snake was found to have died, undoubtedly due to the effects of the spider's venom. This was evident from its condition. The ventral surface, from throat to vent was distended and apparently filled with a fluid - rather like an immense blister. This was especially noticeable at the throat which was considerably swollen. An area of "necrosis" was present on the specimen, situated approximately 40mm from the head. This was probably where the spider had concentrated its attack(s).

Predation upon snakes by spiders has been noted before in literature (De Rebeira 1981; Orange 1989), with varying consequences for the snakes involved. In this case the fact that a small, neonatal (umbilical scar still present) snake had become ensnared in a web, gave the spider a definite advantage despite its size (body length:7.3mm).

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BOOK REVIEW

Australian Reptiles and Frogs (1989) by Raymond T.Hoser.
Pierson & Co. Sydney. Retail Price $49.95.

Australian herpetological work both amateur and professional is an exciting and historic phase.

There can be no doubt that we are in the most significant surge yet of book-length publications on Australian herpetofauna. And this book is an epitomy of several significant factors in Australian amateur herpetology. It is written with an enthusiasm which at times erupts into passion especially on the contentious issues of fauna laws, conservation policy and enforcement.

The book is of excellent design and production with many superb photographs. Its structure is well suited to the material it presents, and I like the inclusion of the section of reptile habitats and the associated photographs. One of the strengths of this book (photography) is marred by wrongly identified species: photo 175 is of *Rynchoedura ornata* not *Lucasium damaeum*, 204 & 5 is of *Lerista punctatovittata* not *Anomalopus mackayi*, 207 is of *Carlia rostralis* not *C.rhomboidalis*, 246 is a species *Calyptotis* not *Hemiergis graciloides*, 470 is of *Aipysurus laevis* not *Lapemis hardwickii*, and 466 is of *Unechis dwyeri* not *U.monachus*. It seems ludicrous to have a photo of a Fire-tailed Skink (photo 263) without a tail! The photographs of variations in some species of snakes (including hybrids) are very useful.

The species accounts cover 38 species of frogs (of a total Australian frog fauna of about 220) and 187 reptiles (of a total of about 650) which the author has encountered and photographed. Thus there are some notable omissions of important and representative species from Western Australia, South Australia and Tasmania. The habitat accounts are strongly biased to Queensland (14), New South Wales (13), and the Northern Territory (11), with Western Australia having 3, Victoria 1, and the other two states none. It is very pleasing to see localities with photographs: editors and publishers of natural history books can extend their books' markets by providing localities for the many animals that have significant geographic variation. Thus some of the ten or so photographs of unidentified frog and reptiles can be quite useful.

The book contains some gems and a goodly number of editorial clangers. I roared with laughter when reading of captive scrub pythons diet: "an average of nine plucked, size 14, supermarket chickens per year." The frequency of wasted words that basically say "little (or nothing) is known.." is annoying and unnecessary. The outline on classification is somewhat confusing and the use of the cline concept is incorrect. It is innaccurate to say the distal toe pads of geckoes are called "suckers" without some qualification. I'm amused and dismayed by the statement (p122): "They are also called Blind Snakes because their eyes are reduced to small spots which give them nominal eyesight." How hybridisation between different genera "will probably assist in the conservation of Australian Pythons" is beyond me, just as is the bald statement that the "pattern of reproductive frequency (in Death Adders) is genetically determined and is not dependent on food availability for females" (p145). Monty Python could have written the explanation (p2) that may have contributed to dinosaur extinction: "meterorites hitting the Earth and rapidly upsetting things." Which plunges into a unique feature of this book: the several "meteorites" hitting fauna protection and its administration. The author's herpetological experience includes the unnecessarily heavy hand of fauna law enforcement, and he alleges that officers in one state's fauna authority were involved in the illegal fauna trade. The references that are supposed to contain evidence of corruption are themselves largely (if not entirely)

hearsay and allegations. It is understandable the author is embittered, and it is unfortunate that his writings are so antagonistic towards the authorities.

The omission of any advice on the legal requirements for obtaining reptiles and frogs (see p177-80), together with his 'A word of warning' (p198: far too brief to help those who want to practice herpetology within the law) deserve criticism. Such a bias is likely to put well-meaning fauna officers and authorities offside with many of the

reforms that are espoused by both professional and amatuer herpetologists (some of these are also dealt with in Hoser's book). Nonetheless the feelings and frustrations expressed in this book are real for many in Australia. It is foolish not to recognise the discontent and quickly restore positive regard and mutual cooperation: society and herpetofauna can only benefit.

The sections on keeping and husbandry contain good general advice with some good photographs of keeping facilities. The detailed sequential photos of the Death Adder and Brown Snake feeding are perhaps extravagant but interesting and probably useful as a teaching aid. The reference and further readings list is also useful. The author deserves congratulations for his perserverence in herpetology (despite the difficulties he has experienced) which has resulted in this book.

In summary: a well designed and illustrated book with useful locality data especially for species variation, but which contains some significant errors, covers about one fifth of Australia's herpetofauna, and is biased towards eastern Australia. It also has a historic component: in years to come it will be (hopefully only) a reminder of the feelings that pervade amateur herpetology. You may not regard this as an essential book for your library but it does add to the now available published illustrations of Australian reptiles and frogs and several variant, hybrids and behaviours.

H.Ehmann.

NOTES TO CONTRIBUTORS

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2. SUBMISSION OF MANUSCRIPT

One copy of the article (including any illustrations) should be submitted, the author retaining a second copy. All material should be type written or clearly hand-written and double spaced. Grammar and punctuation should be checked and all pages must be numbered consecutively. The metric system should be also used throughout. All scientific names and subheadings should be underlined. The author's name and address should appear under the title. Latitude and longitude of the localities mentioned should be indicated.

3. ILLUSTRATIONS

Illustrations (drawings, maps or photographs) should be twice the anticipated published size if possible. Drawings should be in Indian ink on high quality, matt white paper. Author's should retain a copy of each illustration.

4. REFERENCES

Any references made to other other published material must be cited in the text, giving the author, year of publication and the page numbers if necessary, e.g. Jones: (1968,p24). At the end of the article full reference should be given.(See this journal).

5. PROOFS

If any changes, other than minor ones, need to be made to the article, a proof with suggested changes will be sent to the author for his revision. Proofs should then be re-submitted by the author as soon as possible.

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